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Technical Report ARMET-TR-10026

M228 FUZE IGNITER PRESSURE MEASUREMENT, PART 2

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The M67 hand grenade is a traditional pull-pin grenade, widely used by the U.S. Army and Marine Corps. Pulling the pin in the grenade's fuze, the M213 or the training round fuze, M228, releases the spoon and the hammer, which hits the primer at the top of the fuze body initiating the firing train. This fuze is simple and has functioned well and reliably in grenades for decades. Unfortunately, it also has major safety issues. Any unwanted stimulus that causes the primer to function, like fire, initiates the entire fuze train. The large quantities of primary explosive in the detonator can also be detonated by external stimulus with enough energy to function the entire grenade. This report describes the tests that were conducted to measure the pressure generated when the primer was ignited by removing the pin and allowing the striker to impact the primer. This is a continuation of part 1.

15. SUBJECT TERMS

M67 grenade M228 fuze Milliwell pressure sensor Pressure

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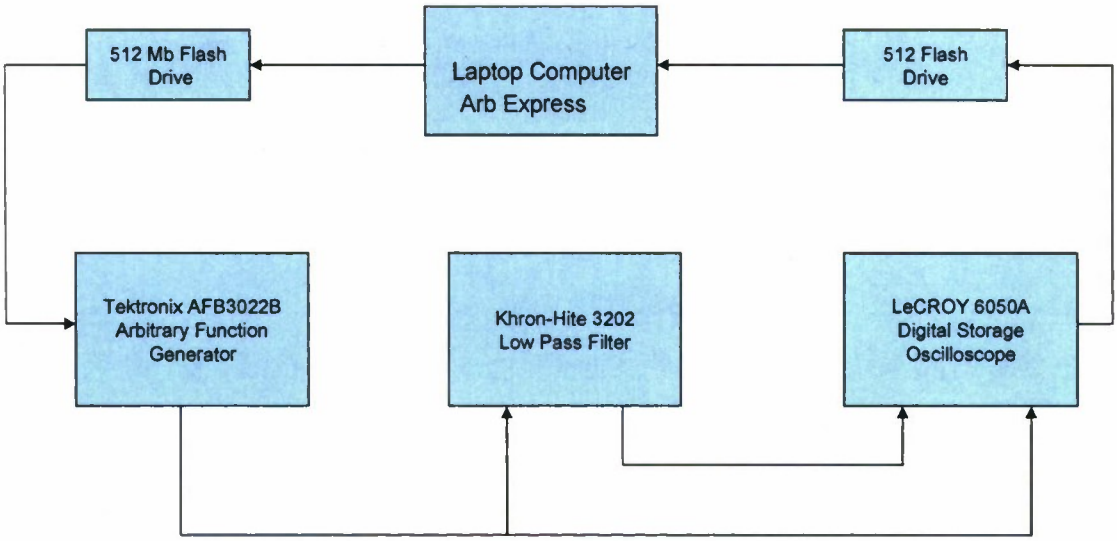
INTRODUCTION

This report describes follow-up reduction of data acquired from tests made on M228 fuze igniters. Those tests are described in the M228 Fuze Igniter Pressure Measurement, Part 1 report. The data reduced in this report was in the form of pressure signals stored in the LeCroy 6050A oscilloscope used to acquire the original pressure signals. Those signals were recreated in a Tektronix 3022A arbitrary function generator (AFG) and applied to the LeCroy through a two-stage fourth-order Butterworth low pass filter, where they were captured and stored. The filtered signals were then analyzed to determine pressure levels and rise times.

DESCRIPTION

Fifty-eight of the 64 signals originally acquired in the M228 fuze igniter tests were recreated and processed through two Khron-Hite 3202 fourth-order Butterworth low-pass filters and then acquired by a LeCroy 6050A digital storage oscilloscope. The recreated unfiltered pressure signals were also acquired by the LeCroy. In order to recreate the original pressure waveforms for filtering and analysis, it was necessary to have saved the waveform in the LeCroy as a binary file when it was first acquired. Then the waveform could be recalled to the LeCroy memory and displayed and mathematically sparsed to reduce the number of data points to less than 64K (49,251 for the pressure waveforms). The sparsed waveform was then saved as an Excel .csv file in a flash drive and read into a laptop computer where header information was removed from the Excel file. The reduced .csv file was then converted to a .tfw file using Tektronix's Arb Express waveform edit program and stored in the flash drive. Then the flash drive was plugged into the Tektronix 3022B AFG's USB port and the .tfw file read into the AFG. The AFG would then recreate the pressure waveform and output the waveform as a voltage signal to the low pass filter and LeCroy oscilloscope.

Six of the 64 original pressure signals did not have resonance generated ringing and therefore did not require filtering. Figure 1 shows the block diagram connections between the instruments used. Figure 2 shows the instruments used for this report. Figures 3 through 58 show the pressure signals acquired. Each of those figures have three waveforms. The top waveform, labeled F1, is the original pressure signal, sparsed by a factor of two. The middle waveform, labeled C1, is a recreation of the F1 waveform by the Tektronix 3022B AFG. The bottom waveform, labeled C2, is waveform C1 passed through the Khron-Hite two-stage low-pass filter. The peak voltage value of the C2 signals were converted to peak pressure values using the PCB pressure system calibration value of 24.21 psi/mV. The final pressure values and signal rise times for each test are listed in table 1.



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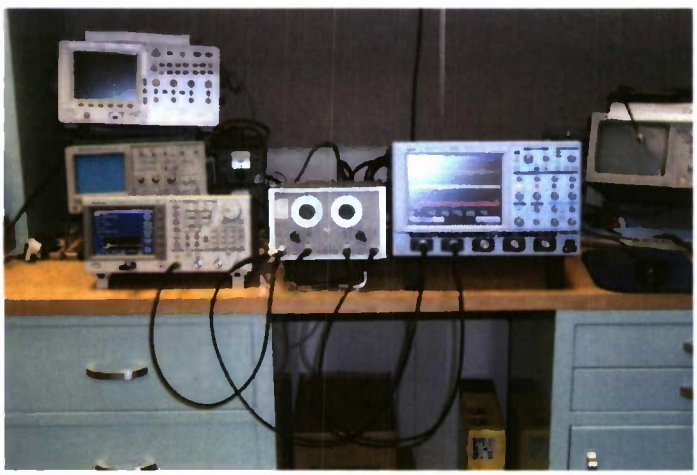
System block diagram



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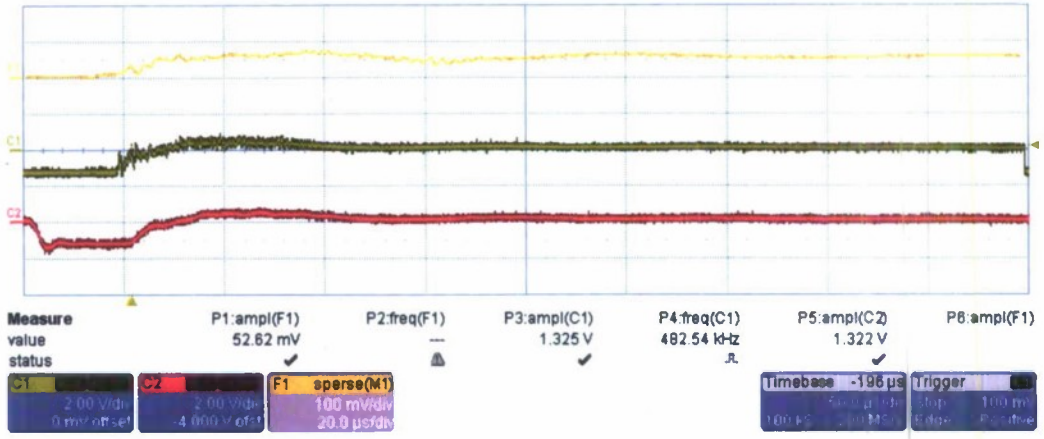
Test instruments



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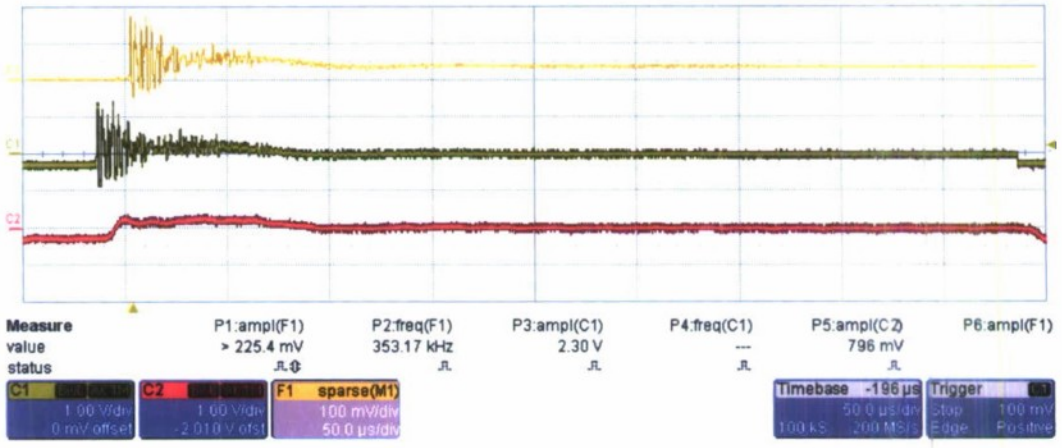

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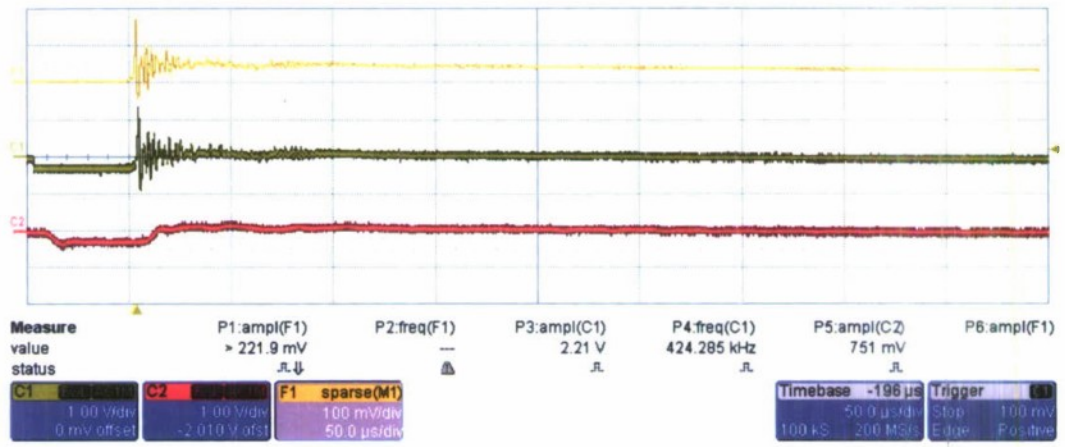

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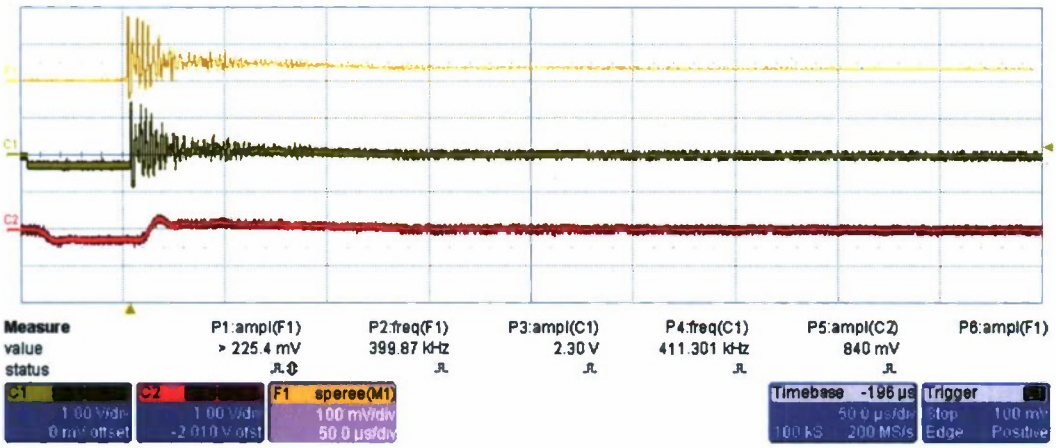

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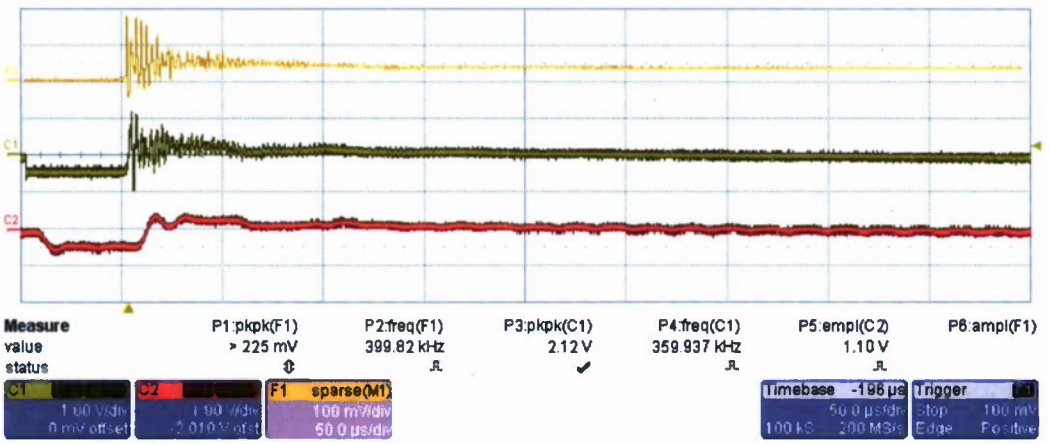

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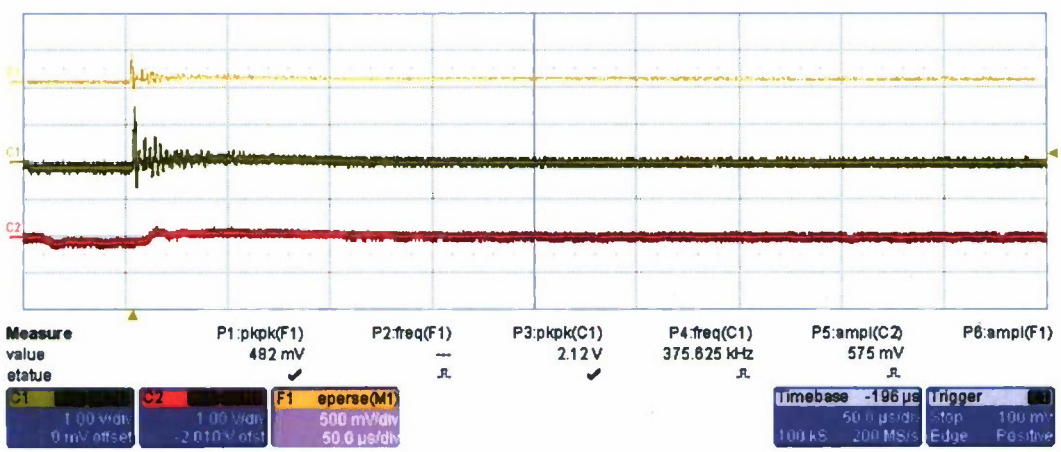

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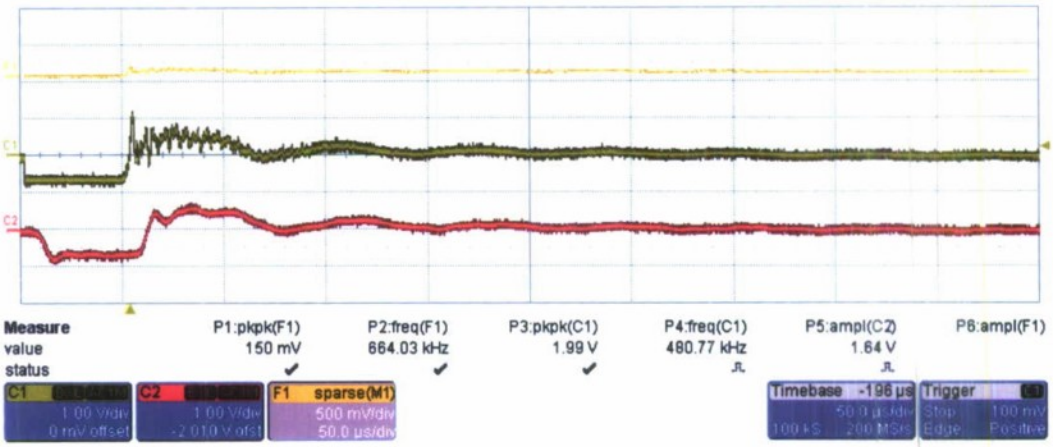

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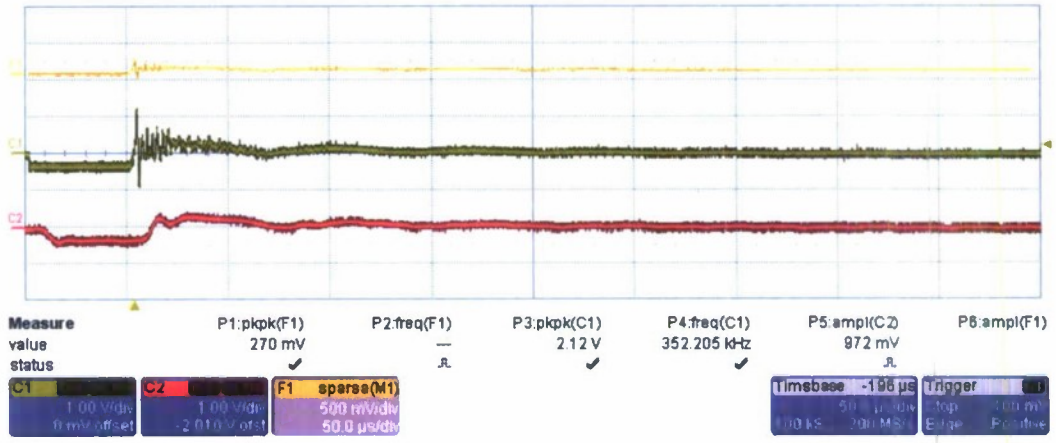

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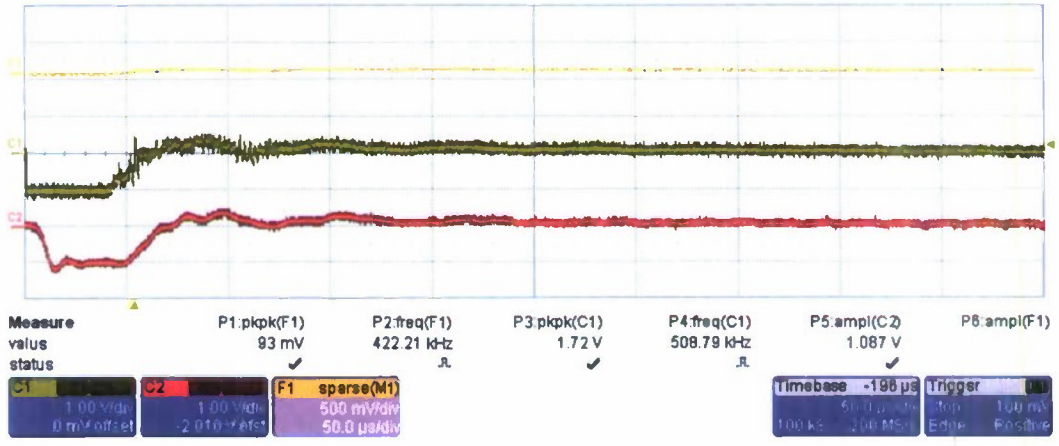

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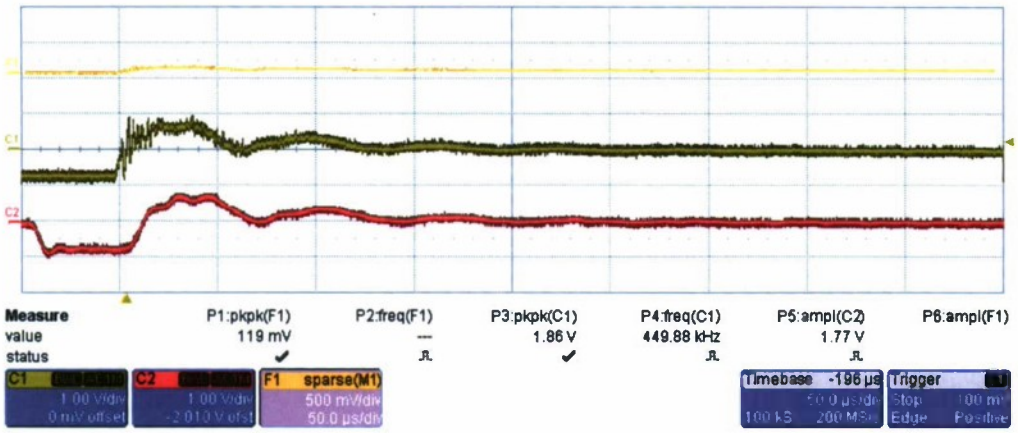

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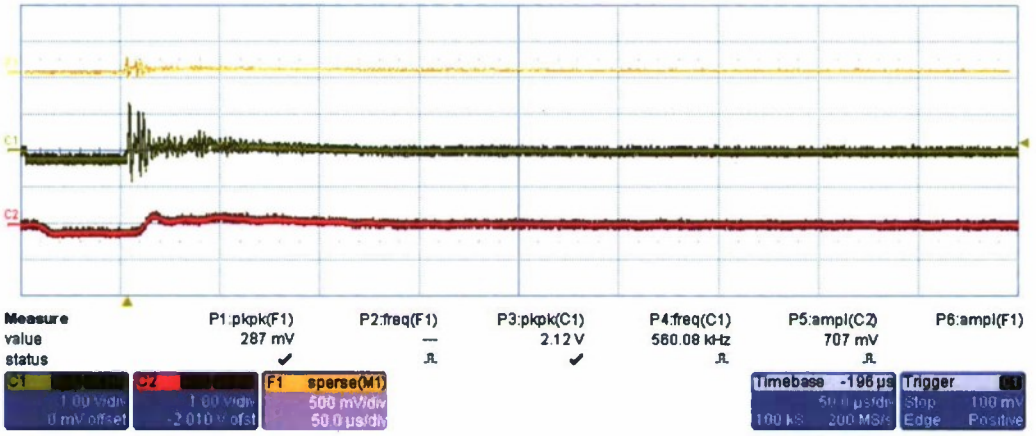

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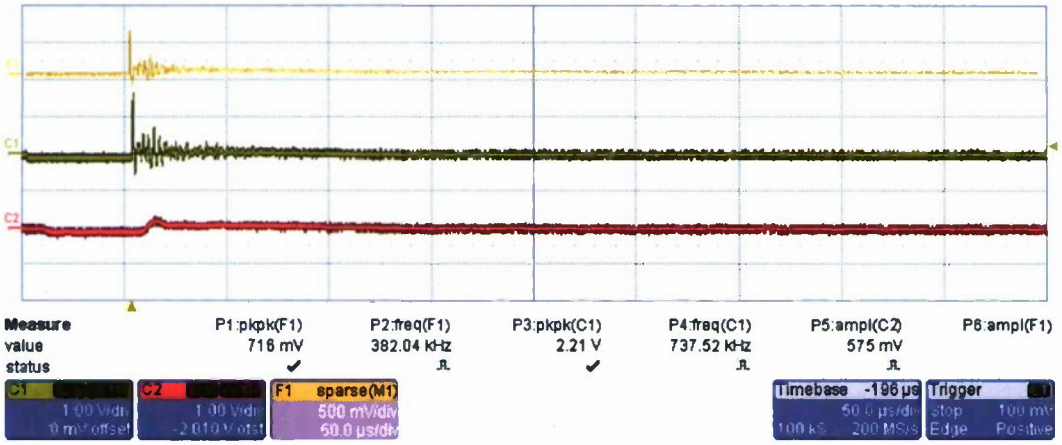

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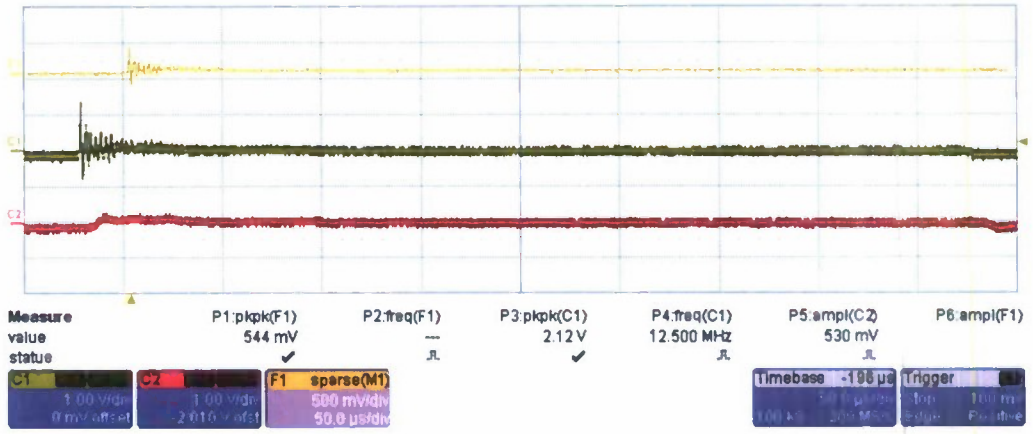

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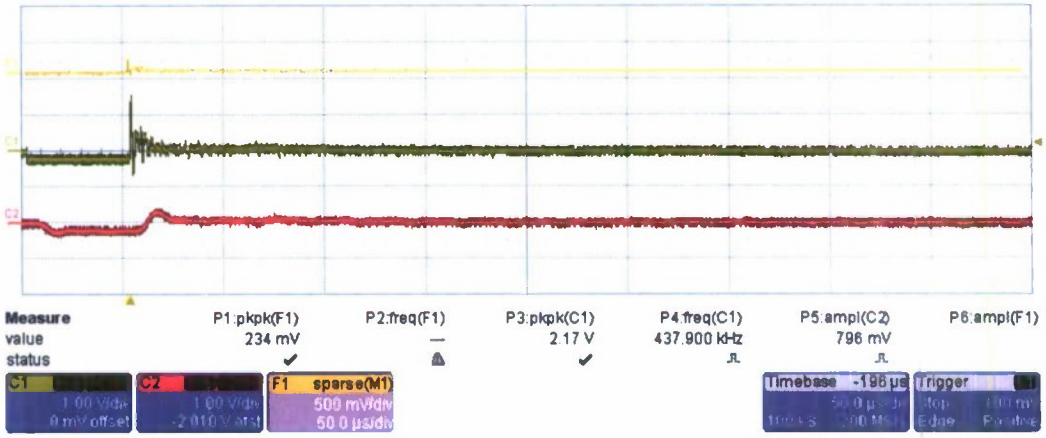

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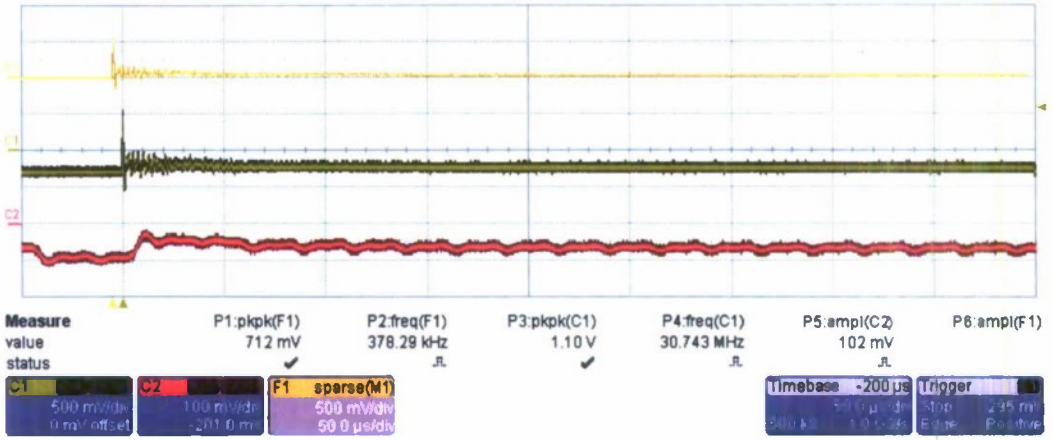

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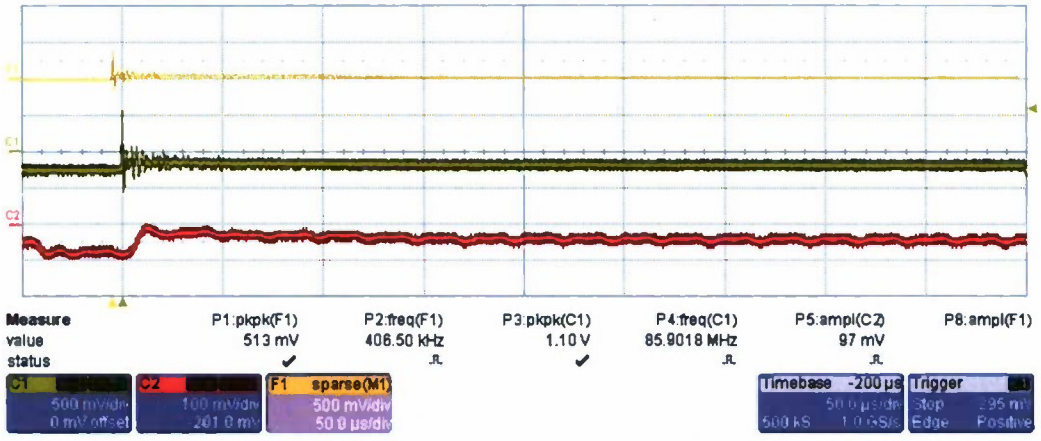

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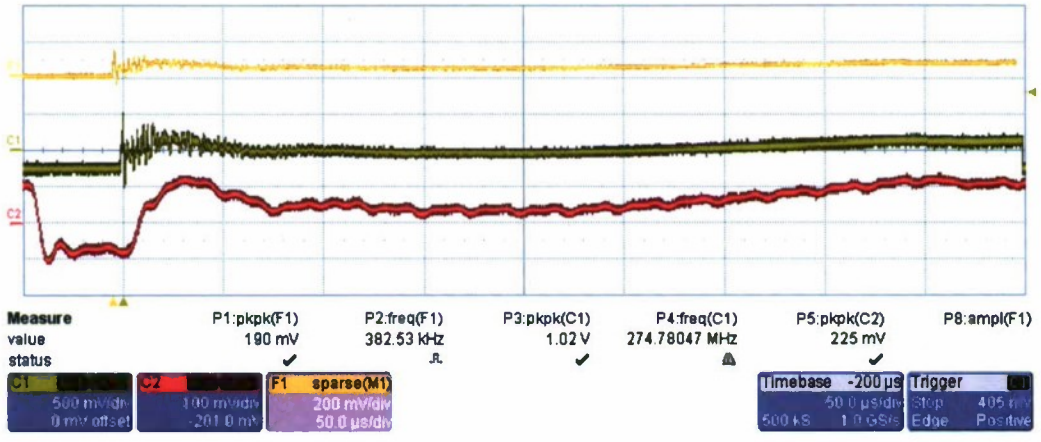

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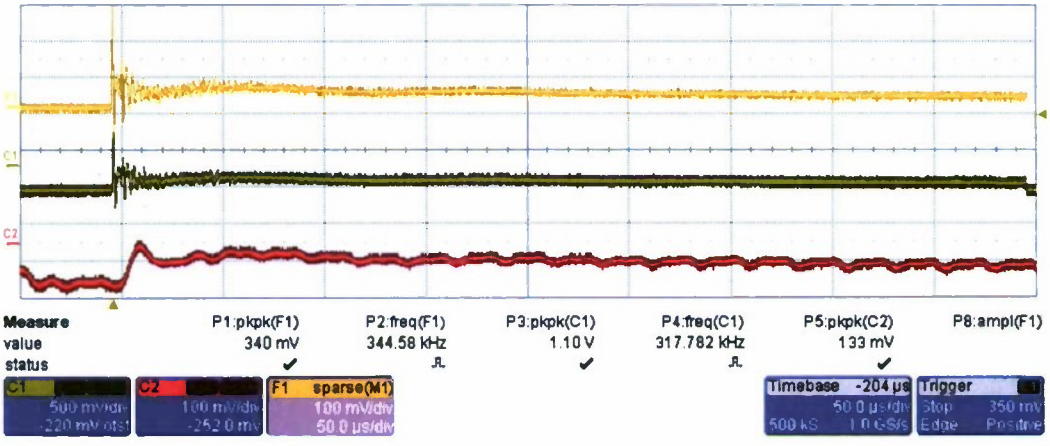

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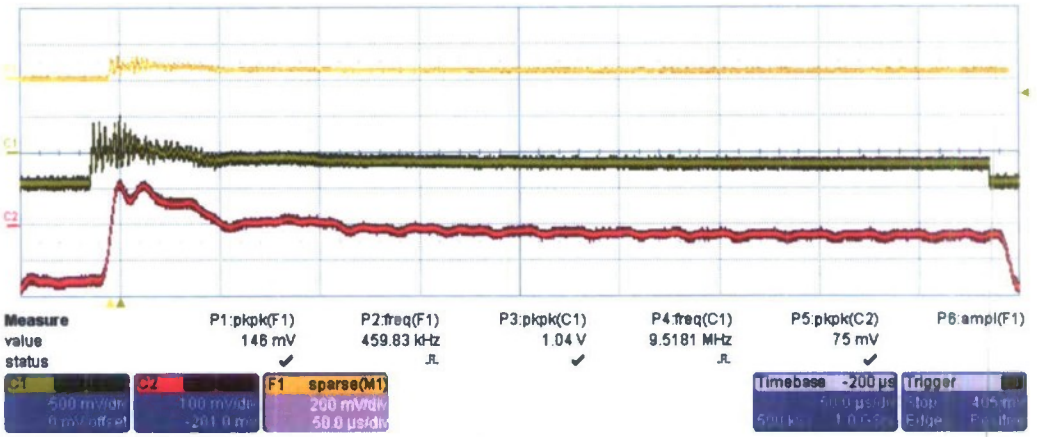

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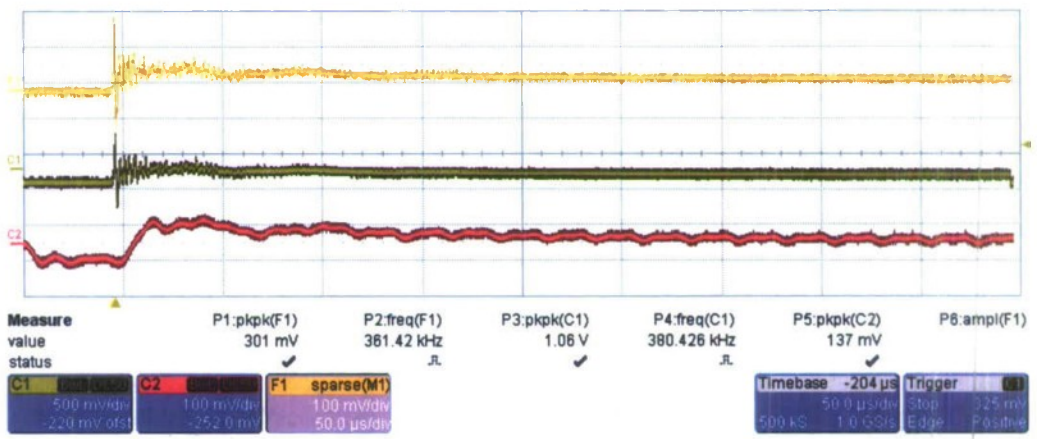

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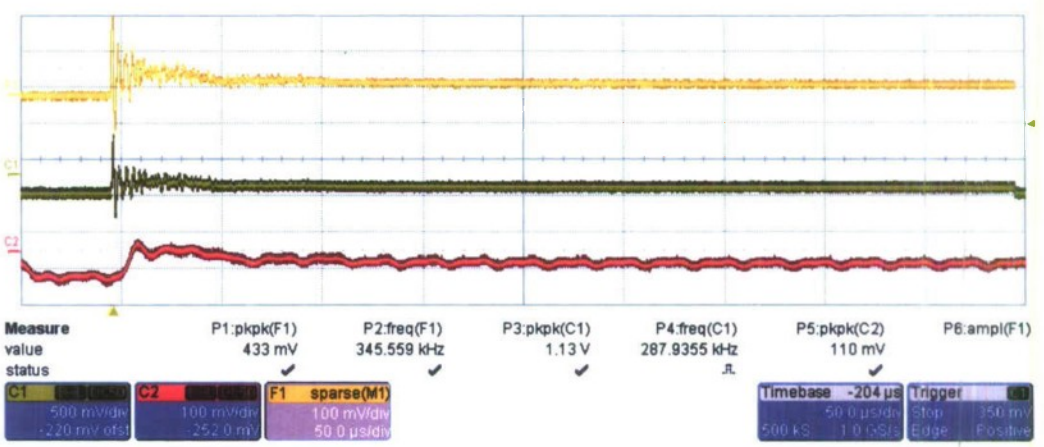

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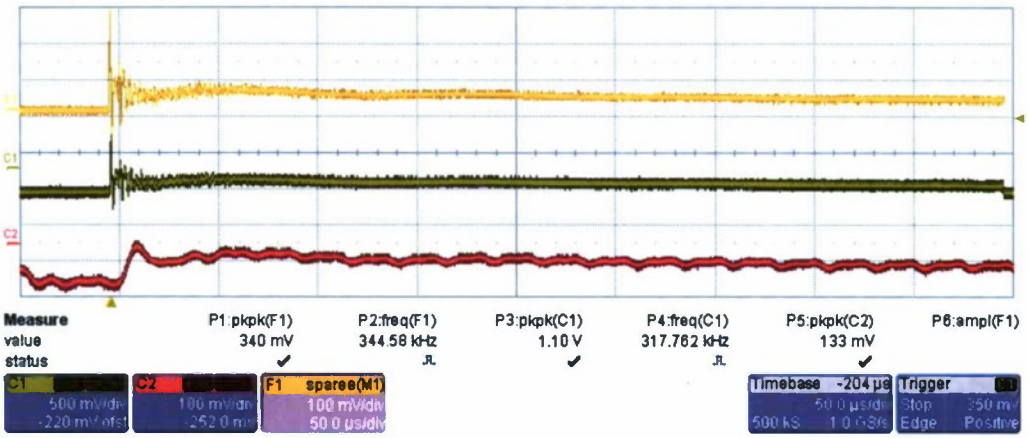

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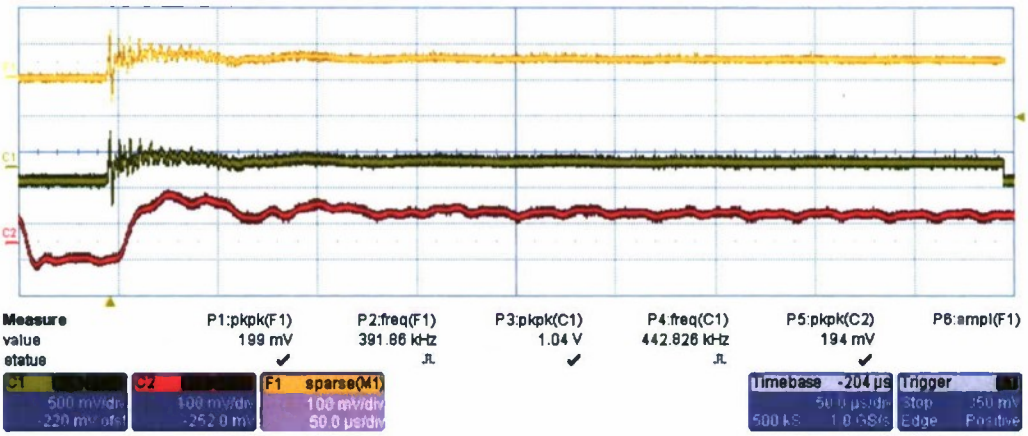

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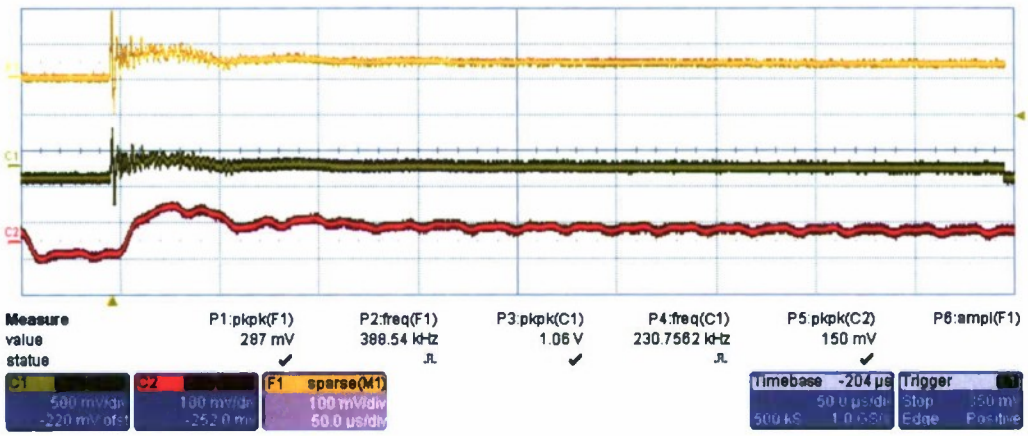

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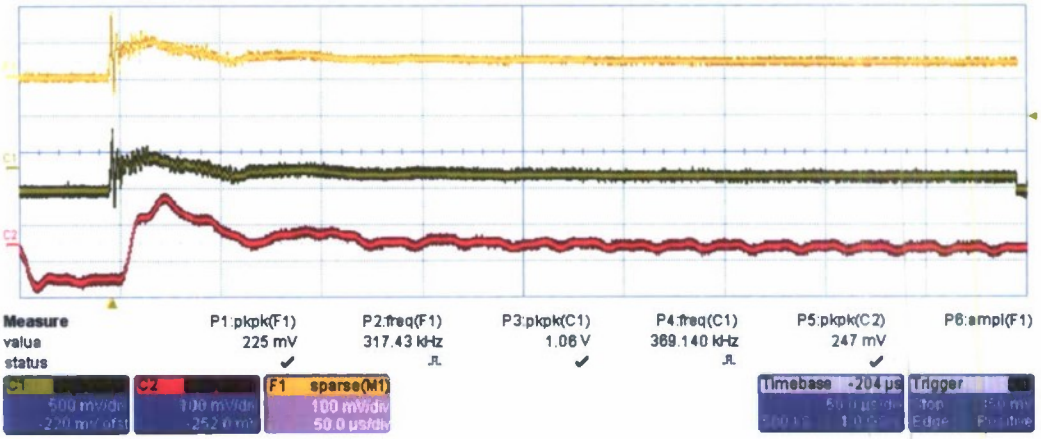

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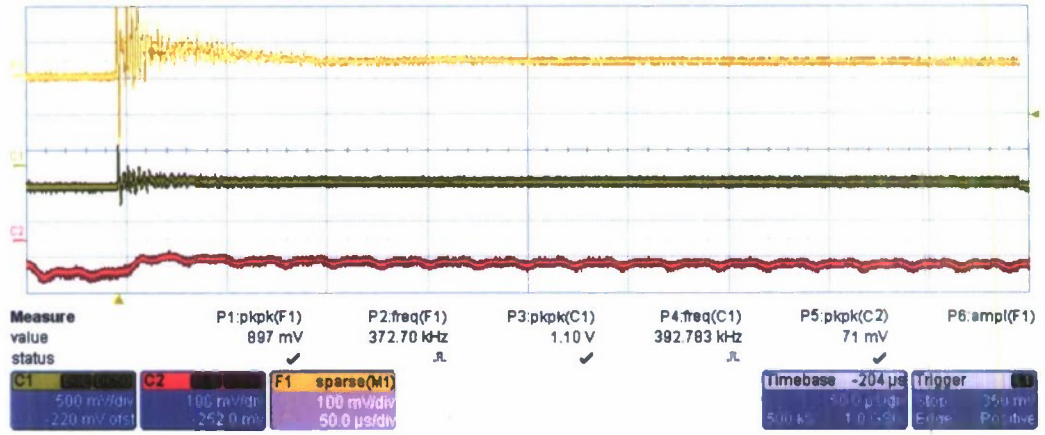

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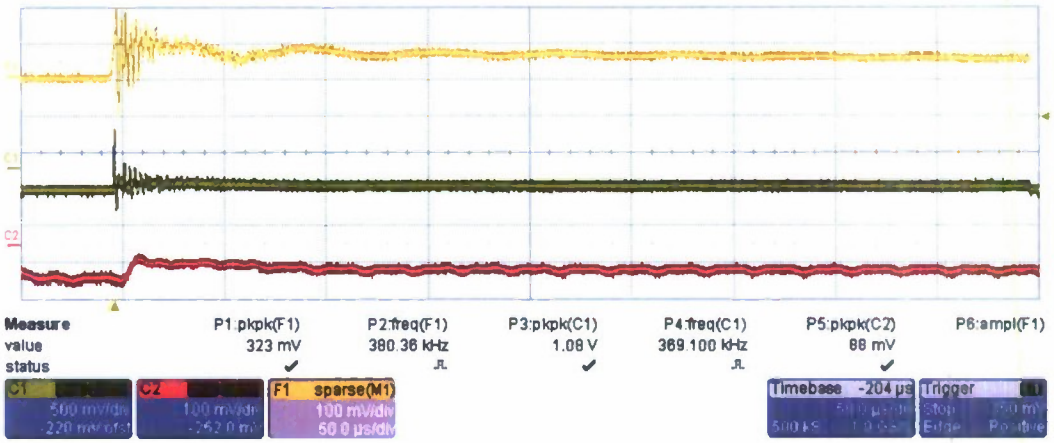

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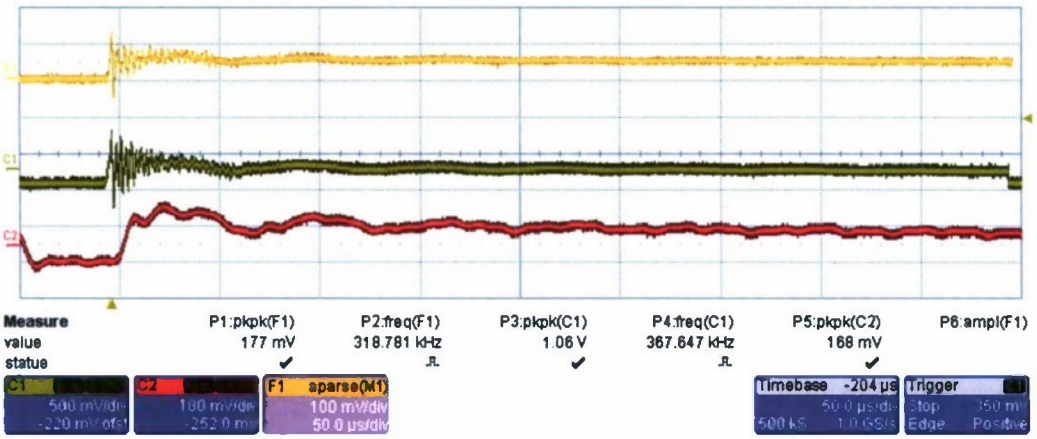

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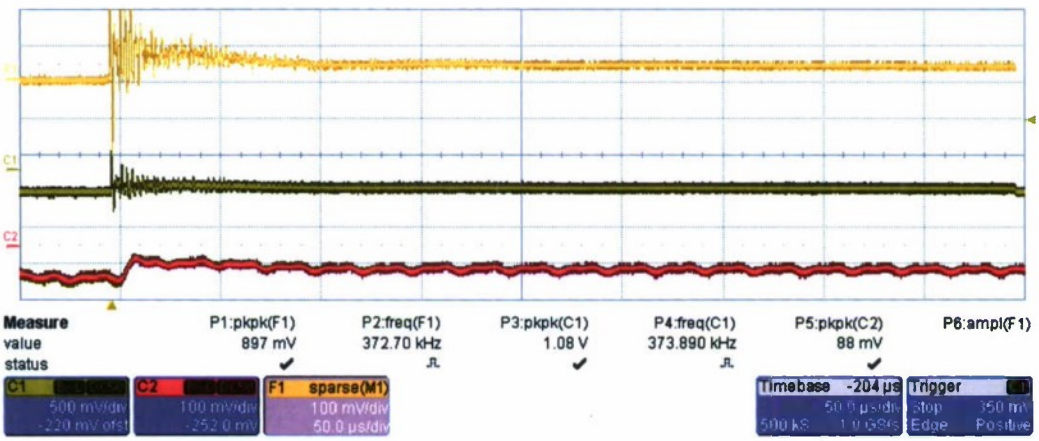

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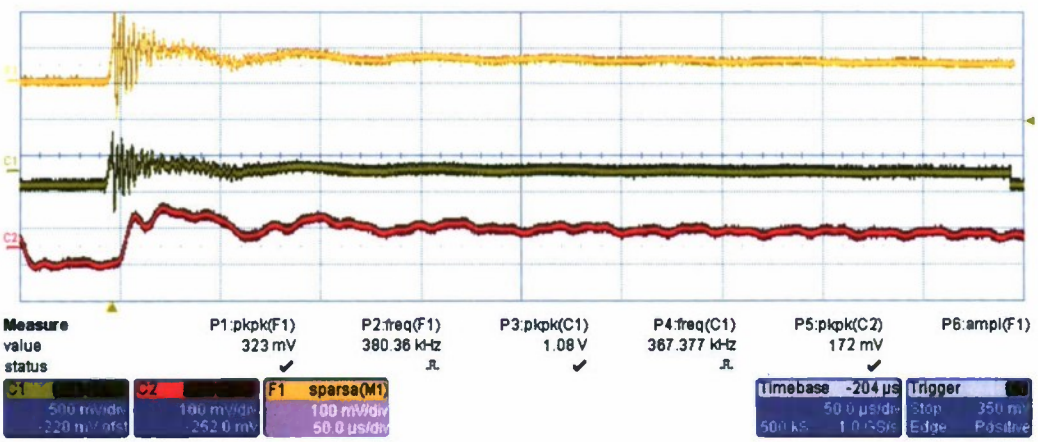

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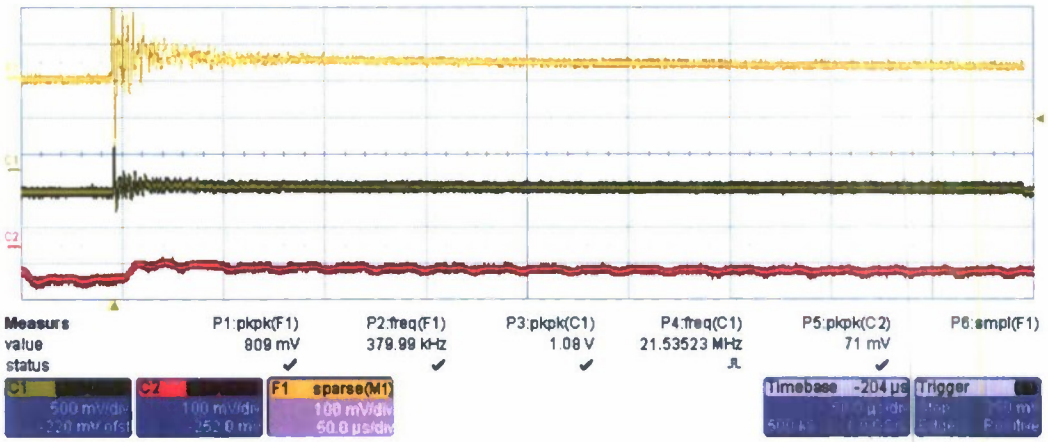

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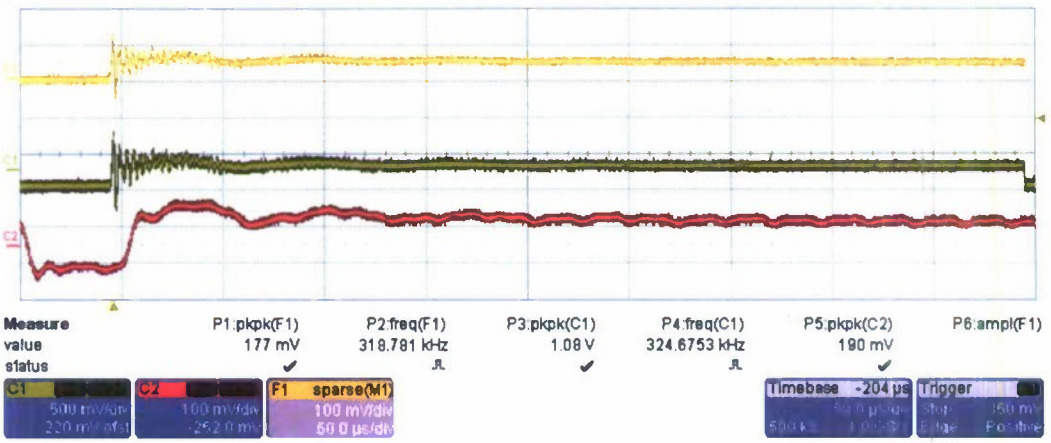

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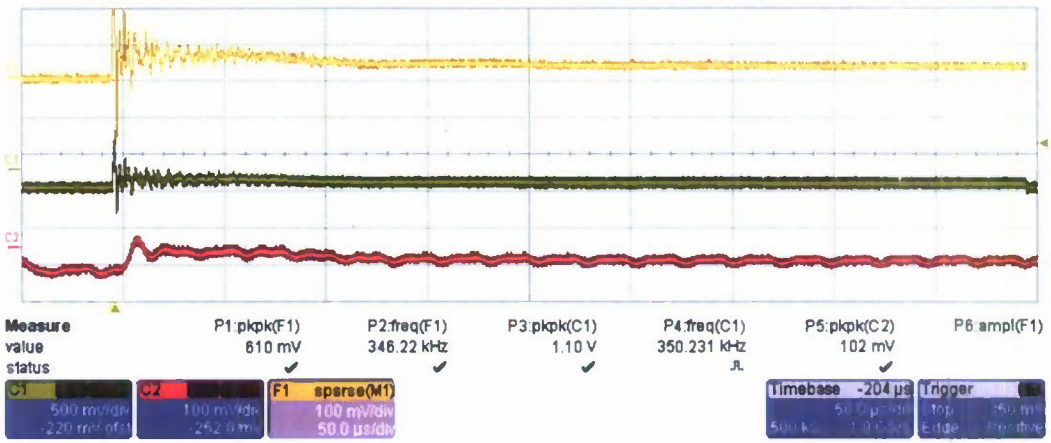

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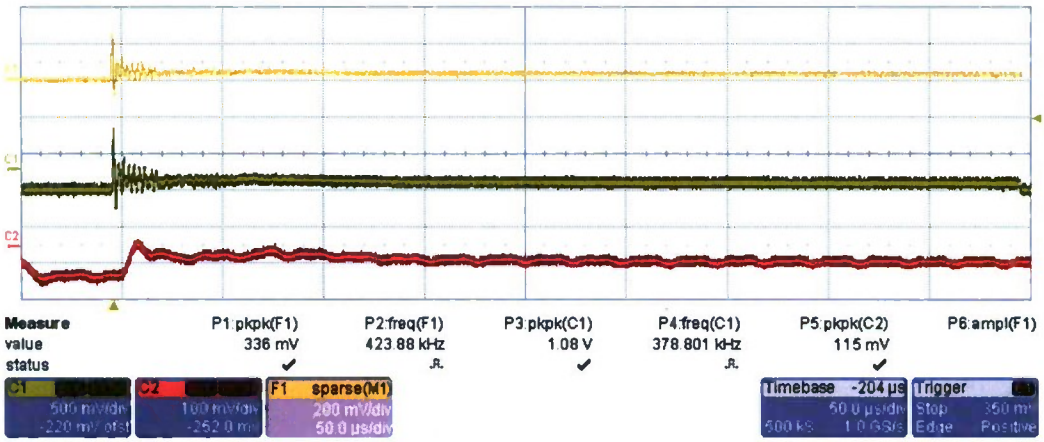

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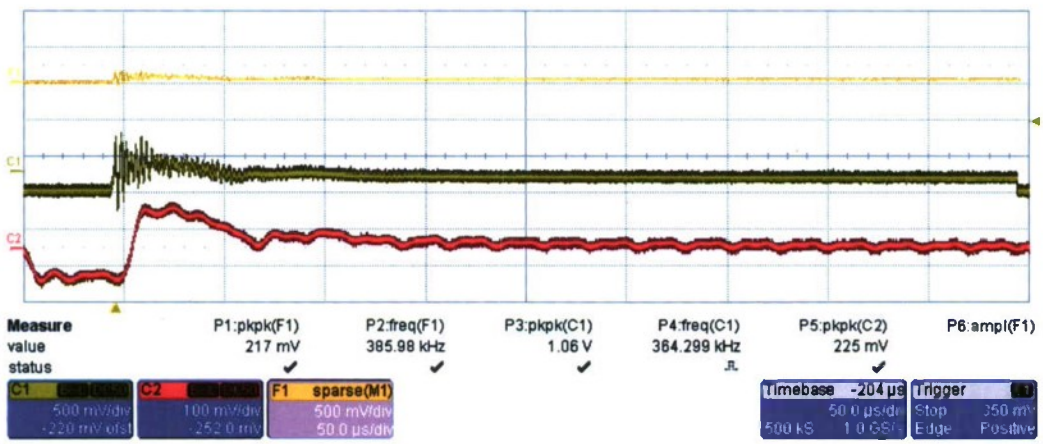

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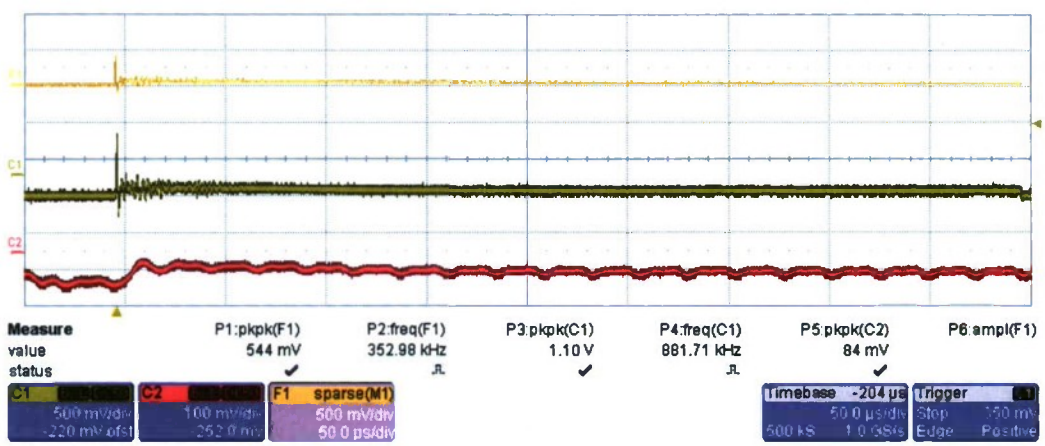

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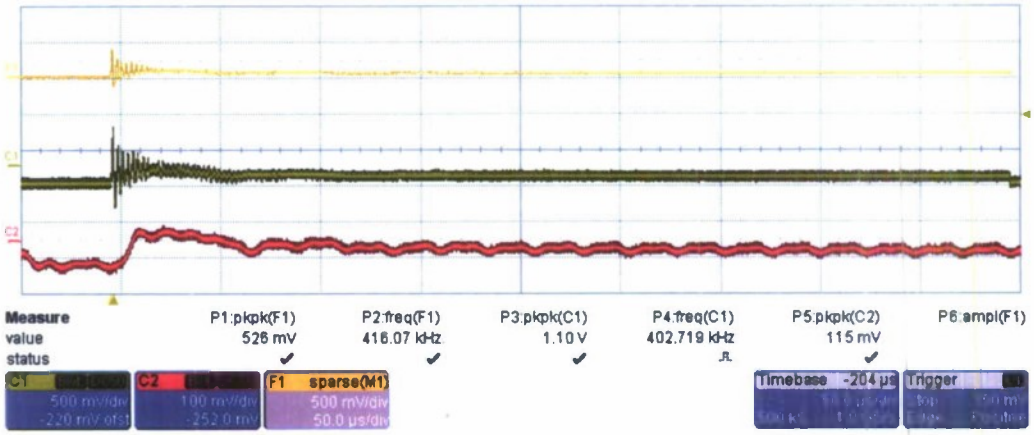

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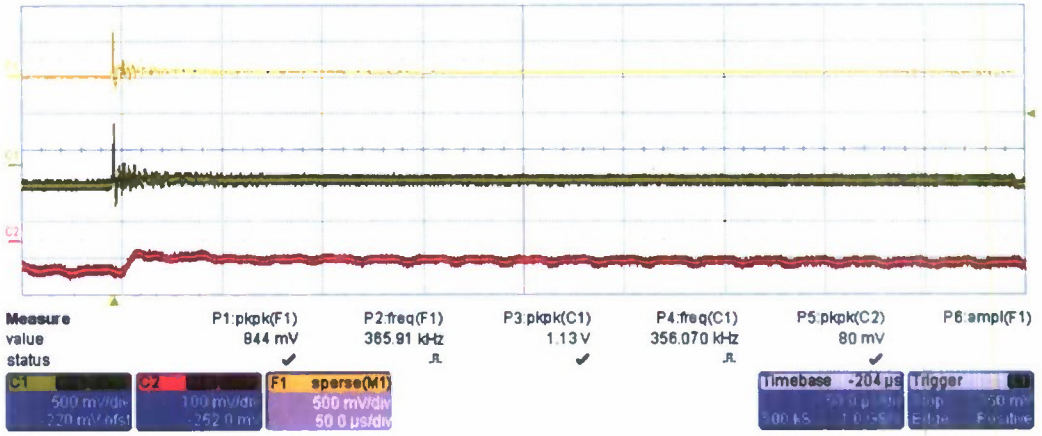

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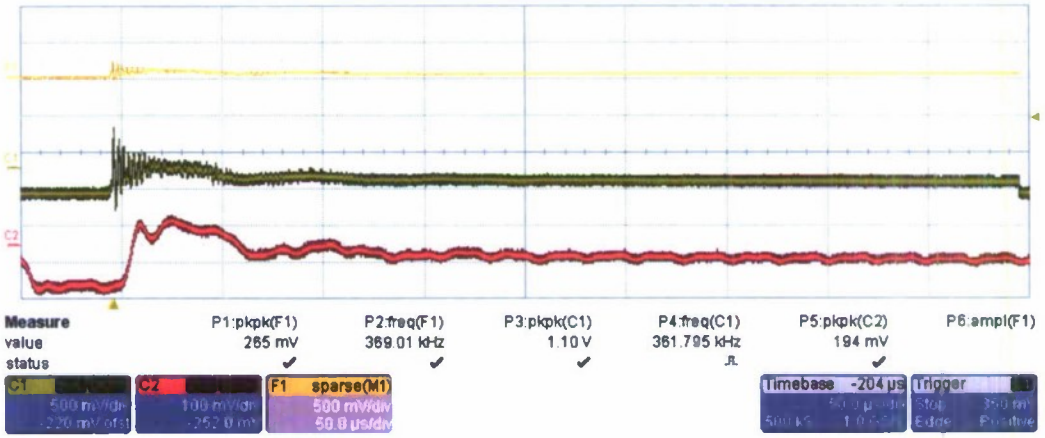

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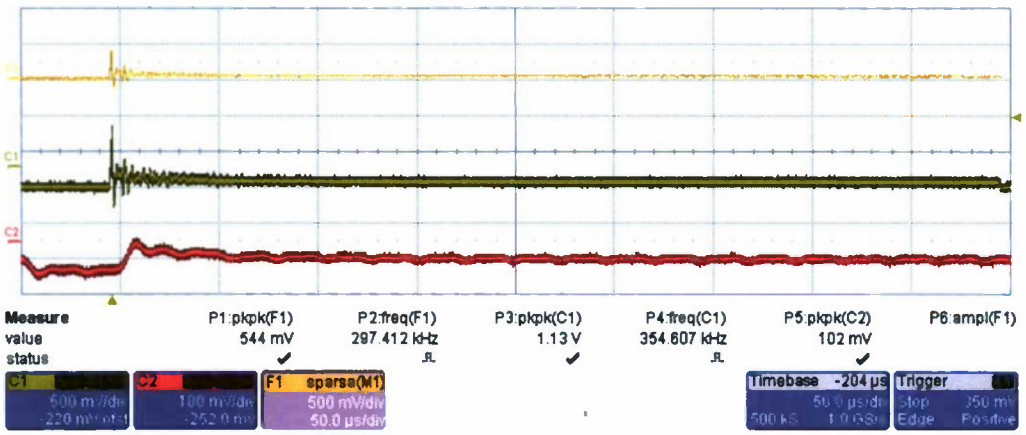

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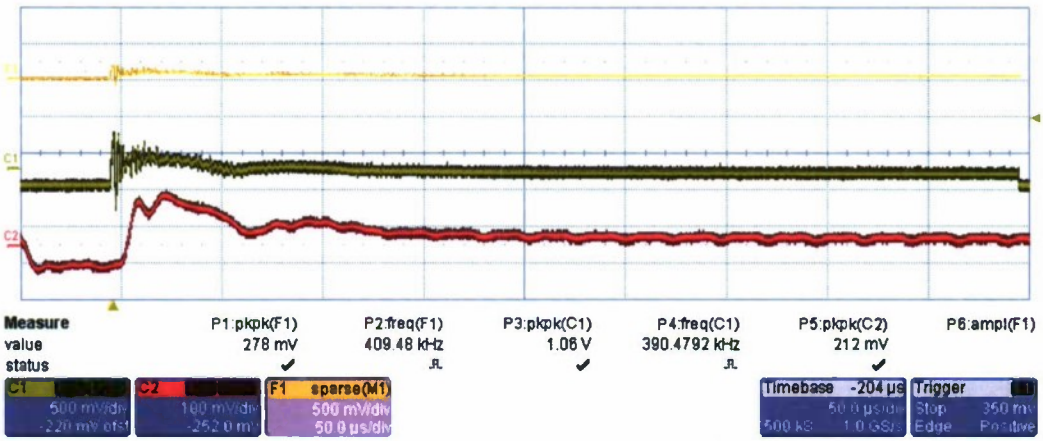

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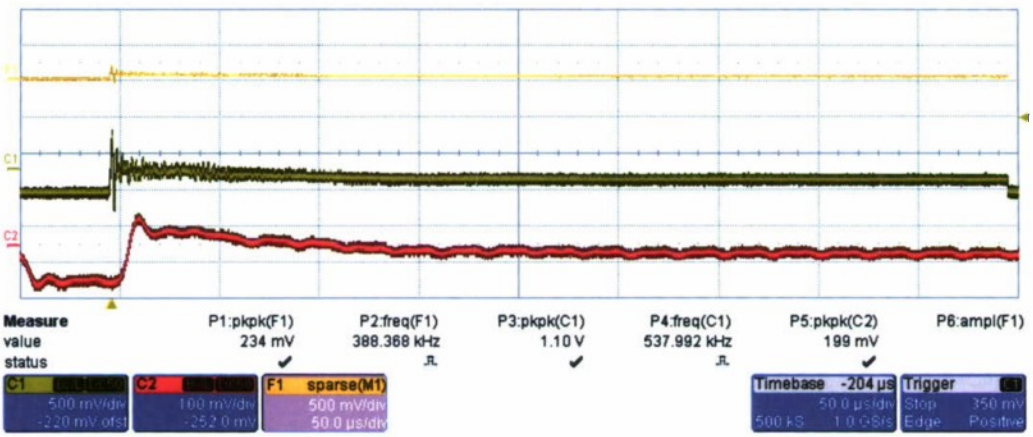

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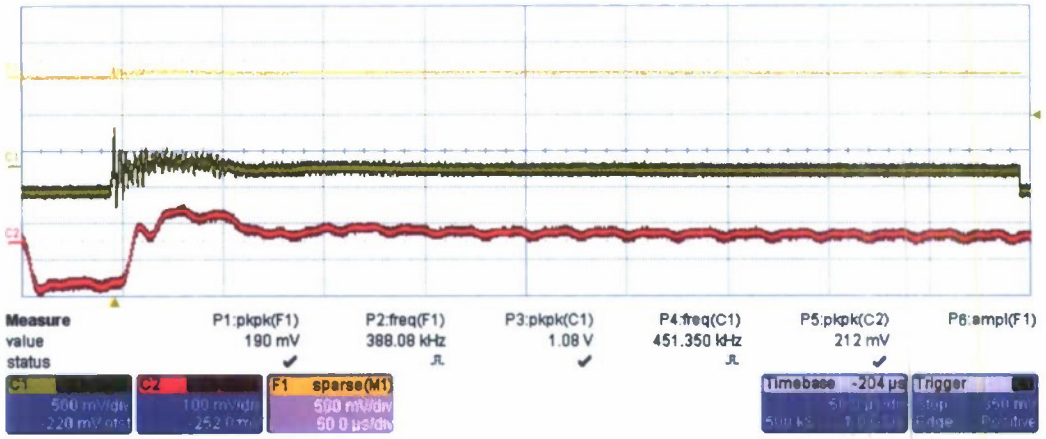

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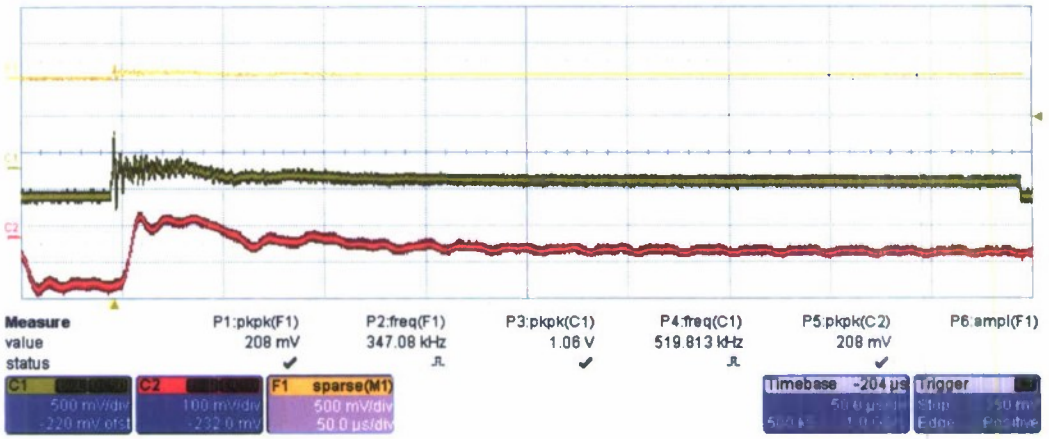

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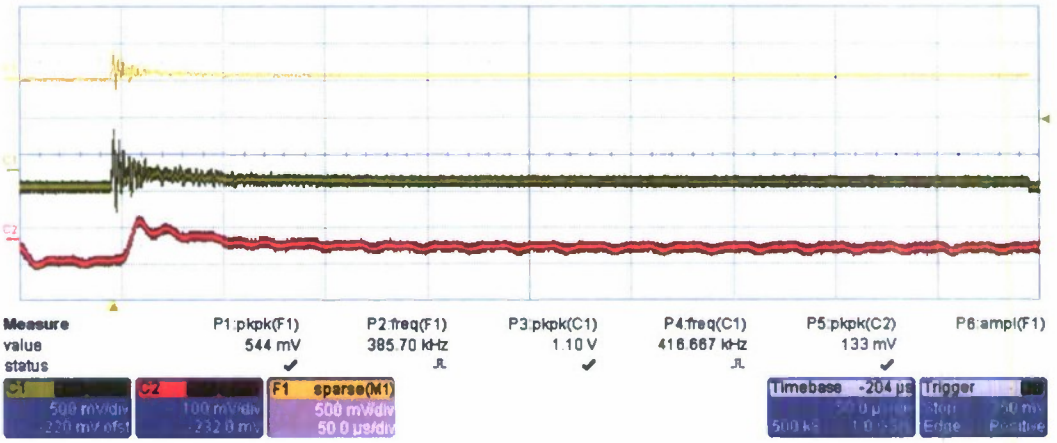

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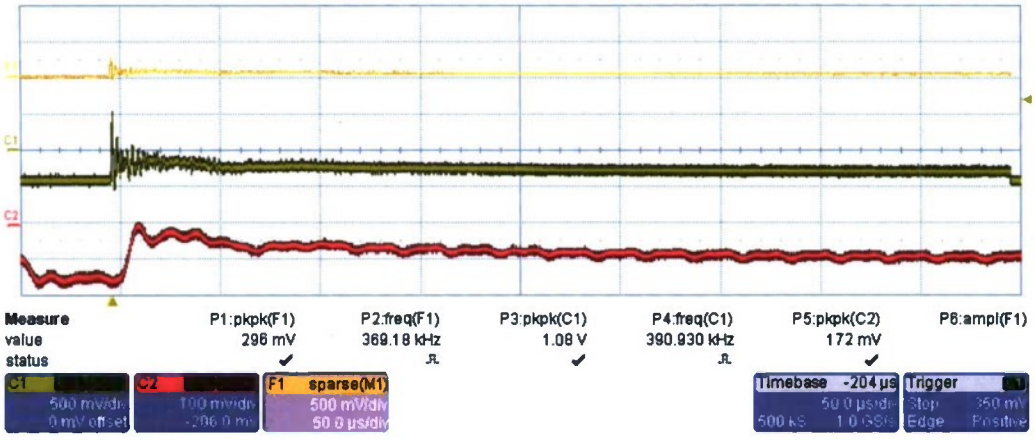

Figure 48
Test 50

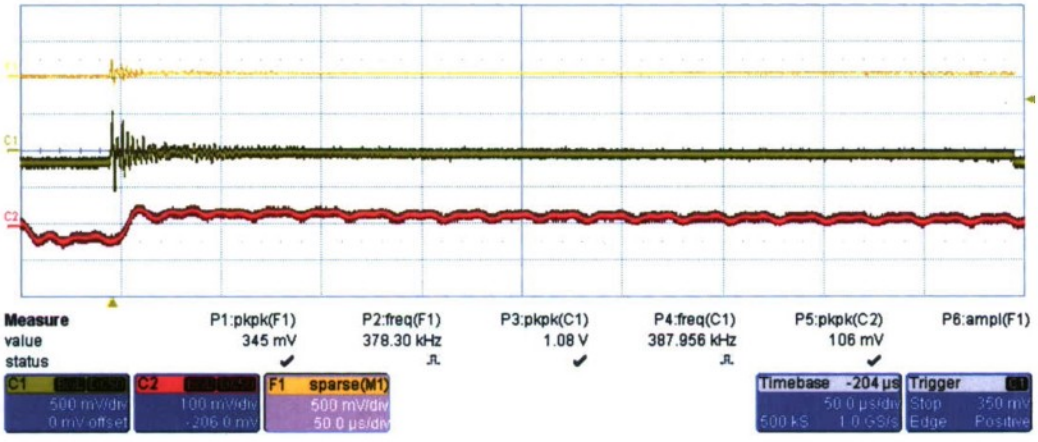

Figure 49
Test 51

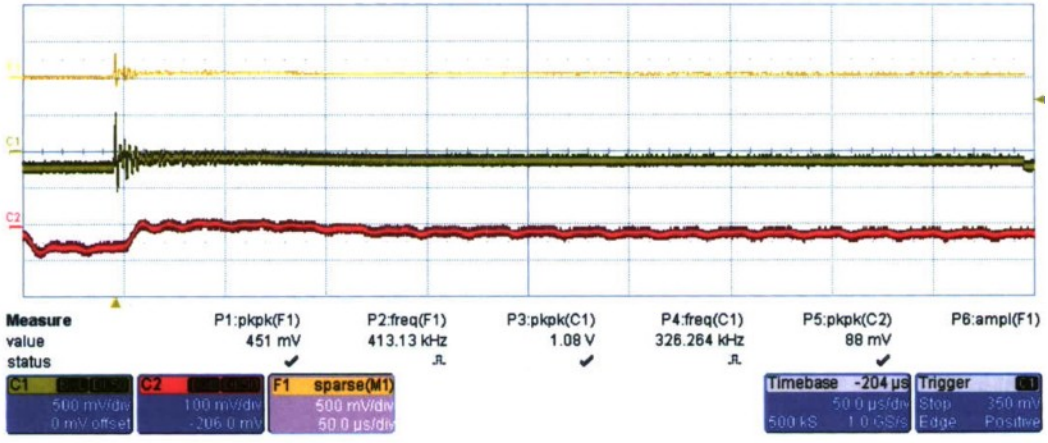

Figure 50
Test 52

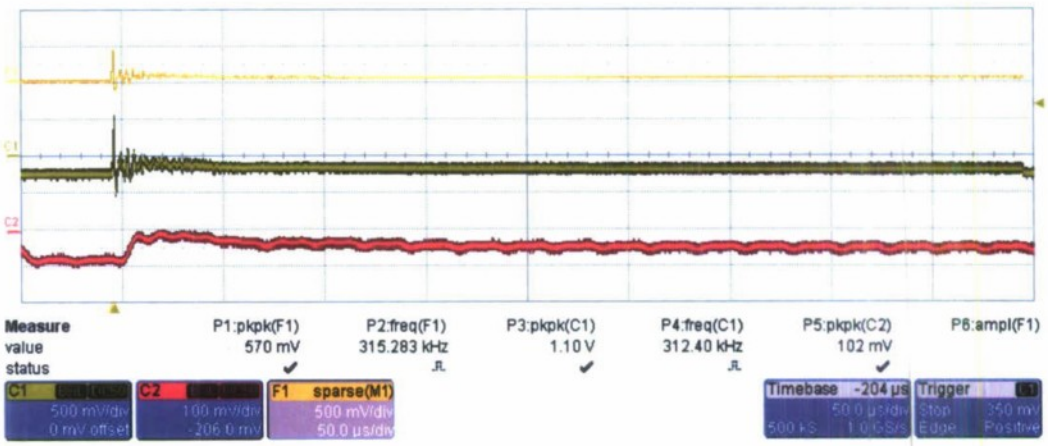

Figure 51
Test 53

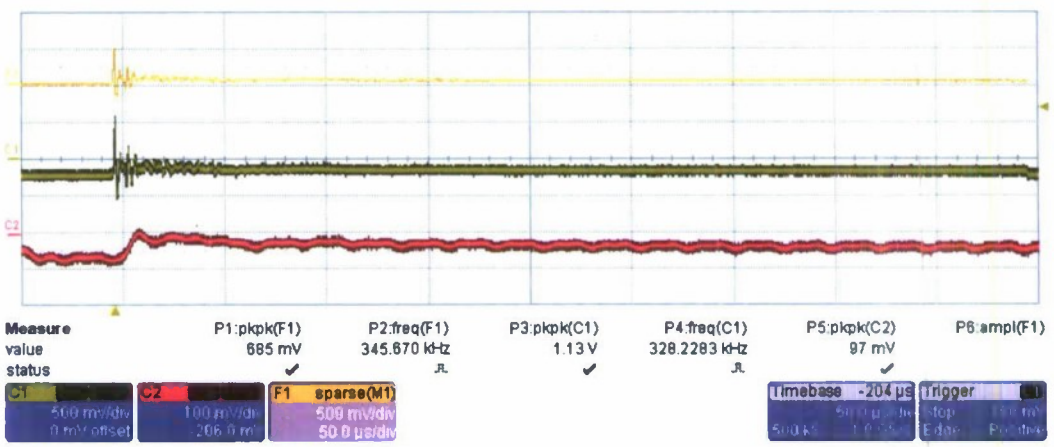

Figure 52
Test 54

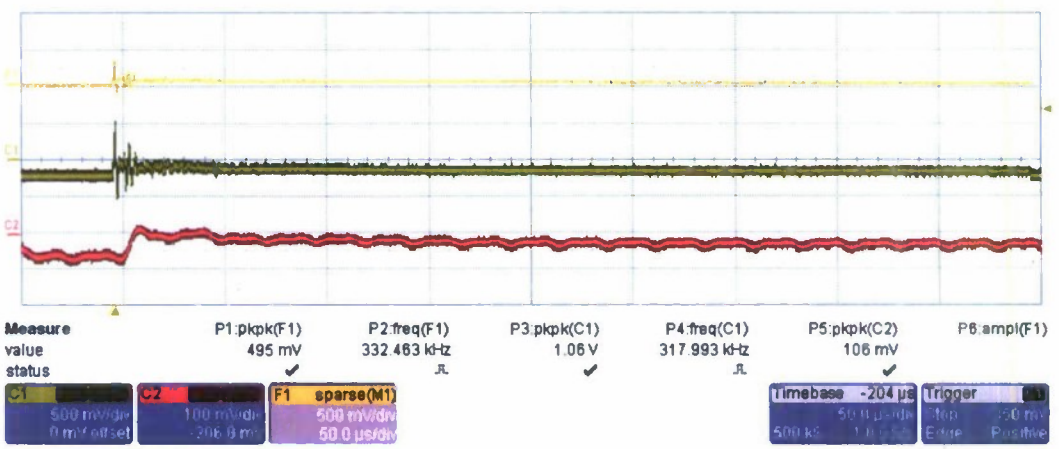

Figure 53
Test 55

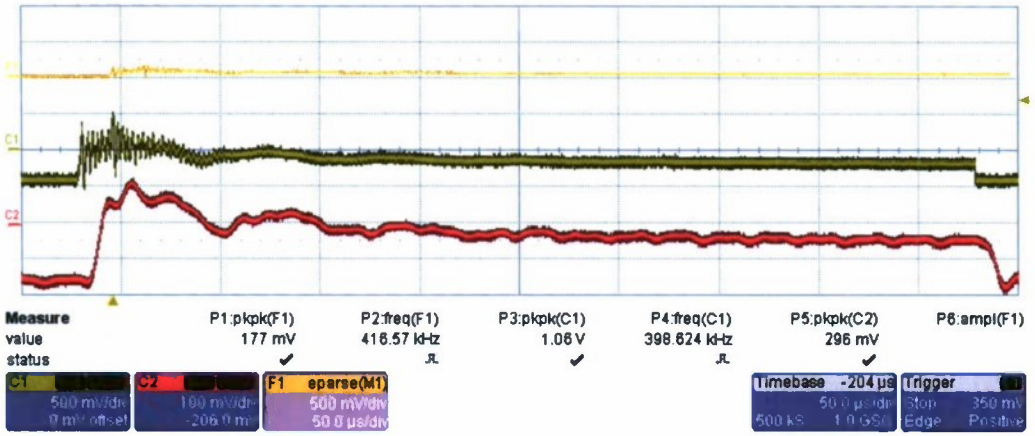

Figure 54
Test 56

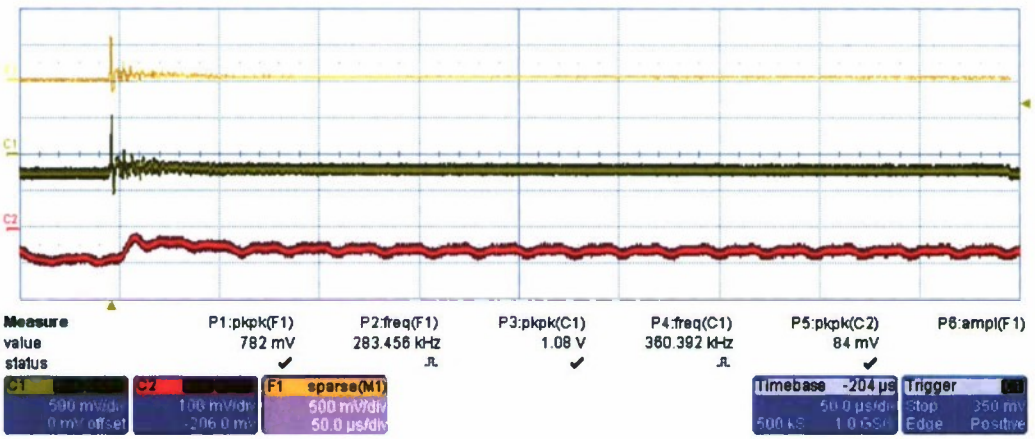

Figure 55
Test 58

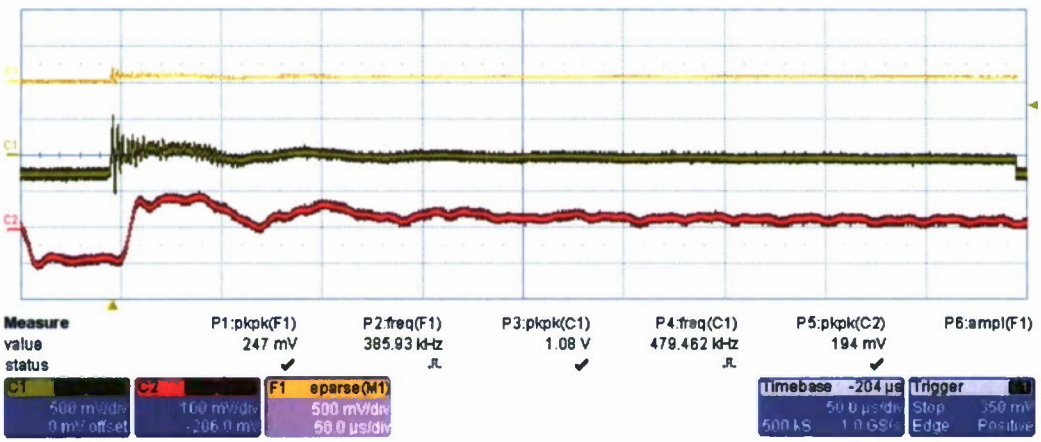

Figure 56
Test 62

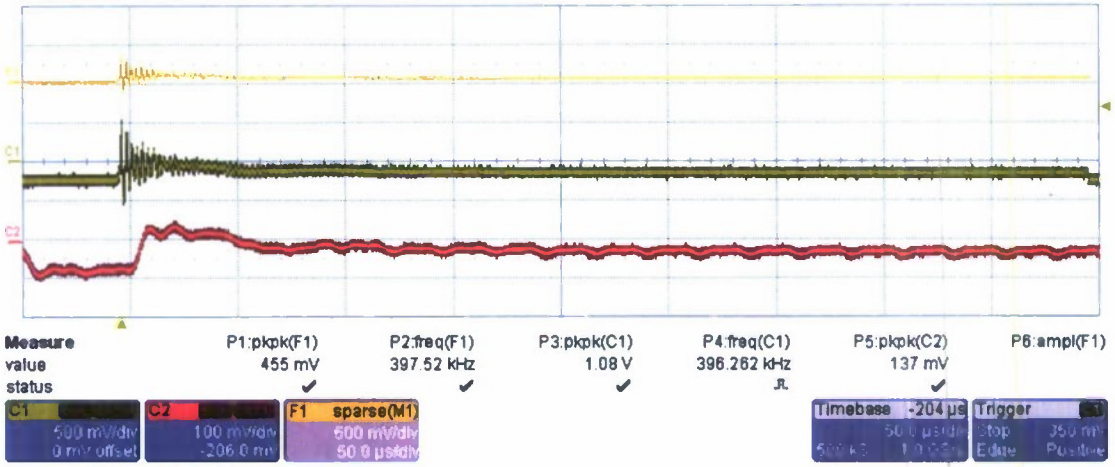

Figure 57
Test 63

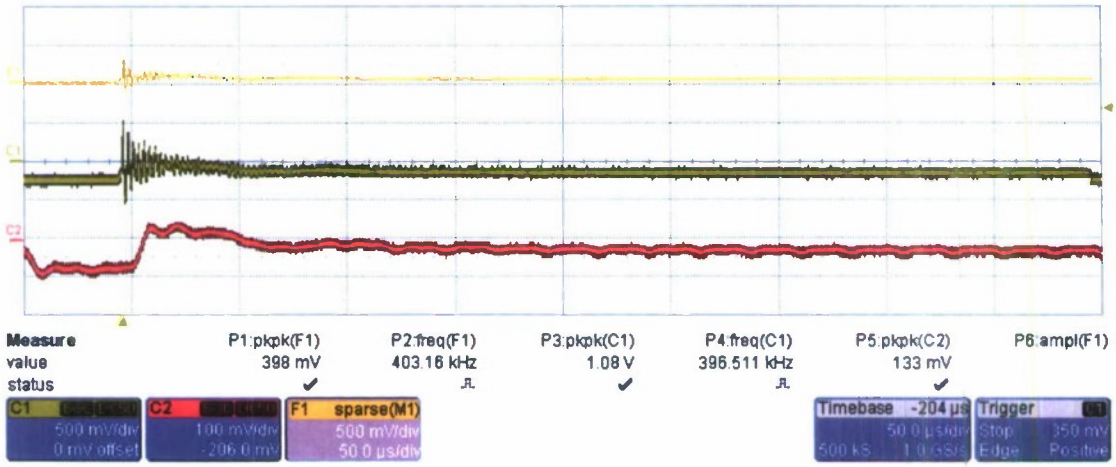

Figure 58
Test 64

Table 1
Peak igniter pressure and rise time

Test no.	Peak pressure (psi)	Rise time (μs)
1	1270	5.0
2	1885	4.6
3	1826	5.7
4	2826	6.6
5	3500	1.0
6	3165	6.5
7	3500	2.0
8	2993	5.6
9	2997	12.0
10	1423	7.9
11	2742	5.8
12	2317	5.2
13	4510	5.0
14	3293	5.0
15	2078	5.0
16	1598	5.2
17	1095	5.3
18	1015	5.6
19	738	4.8
20	942	11.5
21	1020	3.5
22	935	4.9
23	995	5.3
24	983	8.8
25	1269	5.9
26	637	3.6
27	899	4.5
28	1402	4.5
29	970	2.7
30	1288	4.5
31	679	4.5
32	1769	4.9
33	754	4.3
34	1369	5.4
35	866	5.1
36	1115	3.5
37	1005	8.6
38	1331	5.1
39	1447	6.0
40	1132	6.0
41	1189	5.5
42	1346	5.5
43	1700	1.6
44	1025	5.4
45	903	5.4
46	988	5.4
47	1592	5.4
48	1141	5.0
49	820	5.6
50	890	5.0

Table 1
(continued)

Test no.	Peak pressure (psi)	Rise time (μs)
51	1280	7.7
52	1424	4.1
53	1198	7.6
54	1197	17
55	1473	11
56	1074	6.0
57	1900	1.3
58	1397	7.0
59	2100	1.6
60	2400	1.2
61	1200	5.5
62	1187	5.0
63	1318	6.0
64	652	31

CONCLUSIONS

The lowest peak pressure calculated from the filtered pressure waveforms was 637 psi and the highest pressure was 4510 psi. Most of the peak pressures, 44, were between 637 psi and 1600 psi. Most of the rise times ranged from 3.5 to 11.5 μs, with two unusual ones at 17 and 31 μs.

RECOMMENDATIONS

LeCroy offers a digital filter software option for the 6050A oscilloscope that can be used in place of the hardware filter used in this report. With the software filter, a filtered waveform is obtained simply by adding the filter operation to the acquired waveform display. The cost of the filter option is $1,972 (FY08 money). Purchase of this option is strongly recommended.

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